the appalling number of prostrations all over the country last summer, and not to be able to rush the information to the suffering public that the simple use of water—water—any kind of good water, would prevent these prostrations. The loss of salt is enormous. Taste your arm on a hot day on the desert. Persons exposed to high temperatures for a long time must, of course, replenish the salt lost; but for practical purposes, for the casual exposure, water in large quantities is the remedy.

And, for treatment, intravenous salt solution is just as truly a life-saver as in surgical shock or any other kind of dehydration.

This method has now been used in approximately 150 cases, to my knowledge, at Indio, Berdoo Camp, Imperial Valley, and at Boulder Dam, and the results from all reports are so striking that we are anxious to broadcast it to the profession that practically heat exhaustion is dehydration, and that the remedy is fluid intravenously as long as the patient cannot take it in any other way. This remedy is so simple and so obvious, once our attention is fixed upon it, that it should not be overlooked any longer: vaporization to reduce heat—the pouring out of fluid for vaporization. Heart and blood vessels empty. Death from bleeding into and through the skin. Simple mechanics. Fill the blood vessels. And, for prevention—drink, drink.

Already the general knowledge of the need of more water is spreading. More water is being used, and the lower incidence of heat exhaustion in Imperial Valley last summer (1933) has also been asserted to be, at least in part, due to this publicity. Doctor Schofield has told you what it has done at Boulder Dam.

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FRED S. MODERN, M. D. (1135 Pacific Mutual Building, Los Angeles).—The syndrome of heat exhaustion that Doctor Schofield describes represents the failing adaptation of the human organism to high temperatures and low humidity. He segregates two main types: one with a dry skin and high fever, and the other with clammy skin and subnormal temperatures. Common to both types are vomiting, diarrhea, muscle cramps, nystagmus, and unconsciousness. Except for heating or cooling of the body, the treatment is essentially the same: that is, the administration of large amounts of normal saline with glucose intravenously, NaCl orally, and stimulation of the failing circulation.

As Doctor Schofield points out, the primary pathological faults lie in the dehydration and depletion of the NaCl stores of the tissues. Which of the two losses is the primary one, and more deleterious, cannot be determined at present without further investigation.

Frederick M. Allen, who advocated the use of a salt-poor diet in the treatment of essential hypertension, has observed that a small number of patients, so treated, developed signs of "salt privation." These signs, namely, pallor, restlessness, loss of appetite, weakness, irritability, and muscle pains, particularly if the calf muscles are essentially the same as Doctor Schofield described, except that they are milder. The daily administration of 2 grams of NaCl to the diet abolished the symptoms in a few days. We find a somewhat similar picture in pernicious vomiting associated with alkalosis.

It would be instructive to follow the CO_2 combining power of the plasma in these patients from coma to recovery. If it is the loss of the chlorids which produces the symptoms, then there should be a progressive decrease; while if it is due to the loss of the neutral salt or the base, there should be no striking change, or there should be an increase in the alkali reserve.

Doctor Schofield's paper is valuable not only for the importance of his clinical and therapeutic observations, but also for the theoretical questions that his presentation raises, and which demand to be answered.

NON-ORGANIC CONVULSIVE DISORDERS OF CHILDHOOD—WITH SPECIAL REFERENCE TO IDIOPATHIC EPILEPSY*

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II†

TREATMENT OF IDIOPATHIC EPILEPSY

THE therapeutic implications from the foregoing discussion regarding the etiologic factors in idiopathic epilepsy are obvious. However, all practical means of affecting the physiological state of the brain cells are very indirect, a fact which places a definite limitation on the degree of therapeutic success to be expected.

The central objective in the routine treatment of this disorder in the individual child is that of preventing seizures and providing, so far as possible, for normal development of his mental and emotional capacities throughout the entire growth period. Obviously, the immediate aim of all therapy is to remove or at least alleviate the causative abnormalities, so far as these can be identified. The variety of circumstances and agents capable of influencing the occurrence of seizures is so extensive that continuous search must be made for such factors, and repeated therapeutic trials may be necessary before success is attained. Because of the protean nature of the contributing or inciting causes, there is perhaps no other clinical disorder that requires so high a degree of individualization in treatment as epilepsy.

Surgery has a very limited field of usefulness in the present-day treatment of idiopathic epilepsy. It is true that removal of greatly hypertrophied adenoids and tonsils, which obstruct the respiratory passages, and of certain "irritative" lesions, either within or outside of the skull, may be of benefit in the exceptional case. However, the radical operations on the skull, brain, and cervical sympathetics, sometimes advocated without special indications, are to be deplored. It would seem desirable some time in the future, when functional charting of the diencephalon has been completed, to test the efficacy of surgically produced diabetes insipidus in those severe epileptics whose seizures can be successfully prevented by stringent water restriction. The physiological state in diabetes insipidus appears on the surface to be almost ideal for the prevention of seizures in that a negative water-balance is always imminent.

The various aspects of the medical treatment of idiopathic epilepsy in children are schematically represented in Figure 5. The relative importance, which we would attach to the various available therapeutic measures, is indicated by the size of the sector assigned to each. Long experience has

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TABLE 2.—*Sample Diet for Epileptic Child 12 Years of Age, Weighing 44 Kg., F. 195, P. 66, C. 18 Grams (48 Cal. per Kg.) K/AK= 2.7. Total Water 968 cc. (22 cc. Per Kg.) Drinking Water 214 cc.*

Food Materials	Amount	Water	Fat	Protein	Carbohydrate	Excess Acid	Excess Alkali
Breakfast	Gm.	Cc.	Gm.	Gm.	Gm.	cc. 0.1 N	cc. 0.1 N
Bacon, medium lean	30	6	19	3	....	19	....
Eggs—2	100	73	12	13	....	160	....
Forty per cent cream	40	23	16	0.8	1.2	.....	10
Cocoa shells	60	60	....	....	....	.....	....
Orange	75	65	....	....	4.5	.....	56
Butter	20	3	17	....	....	.....	....
Bran squares—*ad lib.*							
Totals		230	64	16.8	5.7	179	66
Dinner							
Lean meat (cooked)	50	24	4	12	....	62	....
"Five per cent" vegetables	100	92	....	1	3	....	65
French dressing, special	10	3	6	....	0.2	9	....
Brazil nuts	15	1	10	2.5	1	....	9
Green olives (preserved)	15	12	2	0.3	0.3	....	30
Milk "substitute"	100	76	20	4	1	....	12
Butter	20	3	17	....	....	....	....
Bran squares *ad lib.*							
Totals		211	59	19.8	5.5	71	116
Supper							
Beef, mutton or turkey, medium fat	140	84	28	25	....	154	....
"Five per cent" vegetables	150	138	....	1.5	4.5	....	97
Avocado	30	18	7	0.6	2.0	....	22
French dressing, special	22	7	13	....	0.4	19	....
Cream forty per cent	30	18	12	0.6	0.6	....	7
D'Zerta one serving	2	50	....	1	....	10	....
Butter	15	1	12	....	....	....	....
Bran squares *ad lib.*							
Totals		316	72	28.7	7.5	183	126
Totals for day		757	195	65.3	18.7	433	308

demonstrated that the best plan of therapy is one which simultaneously utilizes all factors known to favor prevention of seizures. For the sake of convenience, however, the different aspects of the treatment will be discussed separately.

Mental and Physical Hygiene.—Under the general heading of "Hygiene," it will be observed that the sector for mental hygiene far exceeds in importance that for physical hygiene. As regards the latter, it is obvious that removal of all physical abnormalities is a rational procedure, and that establishment of good physical health habits is desirable. Regular muscular exercise in the form of interesting constructive work, or of supervised outdoor play, is helpful. Idleness, especially when it follows long periods of regular and active work, is conducive to seizures. Overeating, a common habit among epileptic children, should be prevented.

The importance of the mental hygiene factor in many cases of epilepsy can hardly be overestimated. The patient and those associated with him may fail to recognize the relationship between certain mental stresses and the occurrence of seizures until this is pointed out to them by the physician who recognizes the significance of such intangible factors. Periodical surveys of the emotional experiences and the social relationships of the epileptic child should be made with the hope of avoiding situations involving mental conflicts, undue excitement and unnecessary anxiety of all kinds. An uncongenial school or home atmosphere and work requirements, or responsibilities beyond the capacity of the patient, may account for his failure to respond satisfactorily to other forms of therapy. No effort should be spared to improve the disdainful attitude of the public toward the epileptic and his problems. The child should be made to acquire a philosophy of optimism and self-reliance without conceit. So far as possible, his environment and his activities should be those arranged for the normal child. So long as he shows little or no mental deterioration, he is better

TABLE 5.—*General Guide for Calculating Diet*

1. *For Children of Pre-School Age:* (or body wt. up to 19 kg.)
   Total water .....40 to 30 gm. per kg. of body weight
   Protein ..... 2.0 gm. per kg. of body weight
   Carbohydrate ..... 0.7 gm. per kg. of body weight
   Fat (gm.) = $\frac{60 \times \text{kilograms of body weight.}}{9}$
2. *For Children Between 5 and 10 Years:* (or 20 to 32 kg. body weight)
   Total water .....30 to 20 gm. per kg. of body weight
   Protein ..... 1.5 gm. per kg. of body weight
   Carbohydrate ..... 0.5 gm. per kg. of body weight
   Fat (gm.) = $\frac{50 \times \text{kilograms of body weight.}}{9}$
3. *For Children Above the Age of 10 Years:* (or above 33 kg. body weight)
   Total water .....25 to 15 gm. per kg. of body weight
   Protein ..... 1.5 gm. per kg. of body weight
   Carbohydrate ..... 0.4 gm. per kg. of body weight
   Fat (gm.) = $\frac{40 \times \text{kilograms of body weight.}}{9}$

off in a private home, or in the regular schools with normal children, than in an epileptic colony or institution.

Dietary Regimen.—For the great majority of growing children with idiopathic epilepsy, the dietary regimen would seem at the present time to be the most promising therapeutic measure available, because it may possibly alter the physicochemical state or the metabolic activity of the body in a direction favorable to correction of the underlying disturbance in brain-cell physiology. Continuous use of effective dietary therapy throughout the entire period of growth might not only prevent mental deterioration and structural damage to the brain by preventing convulsions, but might actually result in permanent correction of the underlying defect.

Without a preliminary trial it is practically impossible to determine which patients will, and which will not respond favorably to dietary treatment. Preliminary encephalographic studies promise to be of assistance in this connection, according to the recent work of Eley,[17] who found that 90 per cent of cases showing normal encephalograms responded favorably, while only 12 per cent of those showing abnormalities improved under such treatment. The metabolic state following three or four days of fasting appears to be ideal for the prevention of seizures. A preliminary fast of this duration or longer, with moderate water restriction, is probably the best test. If a patient does not respond to this procedure, it is not likely that he will be greatly benefited by the ketogenic type of diet to be described later. All three of the major effects of fasting, namely, the endogenous production of sedative agents (acetone bodies), shifting of the acid-base equilibrium toward the acid side, and the development of a negative water-balance, theoretically lower nervous excitability, possibly by their combined effect on cell membrane permeability.

Ketogenic Diet.—Since the beneficial effects of starvation disappear when the fast is terminated, Wilder[18] suggested the use of a ketogenic diet which would furnish a metabolic mixture similar to that found in the fasting state. Results from the use of this type of diet have been very favorable under ideal circumstances. For practical purposes, diets are calculated on the assumptions: (1) that 46 per cent of the protein and 90 per cent of the fat by weight is ketogenic, and (2) that 58 per cent of the protein, 10 per cent of the fat, and 100 per cent of the carbohydrate, is antiketogenic. To be ketogenic, a diet must contain a proportion of fat in excess of that indicated by the formula of Woodyatt ($F = 2C + {}^{P}/_{2}$), and at the same time not exceed the caloric requirement of the patient. It is essential to maintain a high degree of ketosis by keeping the carbohydrate content of the diet low, if maximum effects from the diet alone are to be expected. This is indicated by the presence of strongly positive tests for aceto-acetic acid and for acetone in the urine. When the diet is to be used over a long period of time, as it should be if the patient responds favorably, it must be constructed with the utmost care to avoid deficiencies of all kinds. The total caloric, protein, mineral and vitamin requirements can easily be met if planned for.

Since alkalosis tends to provoke convulsions in the epileptic subject, the purpose of the ketogenic diet can be defeated by the presence of an excess of fixed base. It has been found desirable, therefore, to omit the use of baking soda and other alkalis, and to select dietary constituents, so far as possible, whose end-products after complete metabolism are predominantly acid. Practically all fruits and vegetables, excepting cereal grains, have an alkaline ash, while the latter and all proteins have an acid ash. Because it is desirable to include as much fresh vegetable food in the diet as the carbohydrate and water allowances will permit, it is occasionally found helpful in severe cases to supplement the diet with the quantity of weak hydrochloric acid, or of acid-forming salts (such as ammonium or calcium chlorid) necessary to neutralize the excess alkali occurring in the vegetable constituents.

Restriction of Total Water Intake.—As pointed out above, stringent restriction of the total water intake tends to prevent convulsions in many cases of severe epilepsy, even when the patient is on a non-ketogenic diet and is taking no drugs. There is usually an initial loss of weight as in the case of fasting or the use of the ketogenic diet. However, in the majority of severe cases the degree of water restriction required for control of seizures is so stringent that continued coöperation on the part of very young patients is almost impossible to obtain without constant supervision. No exact rule regarding the amount of water to

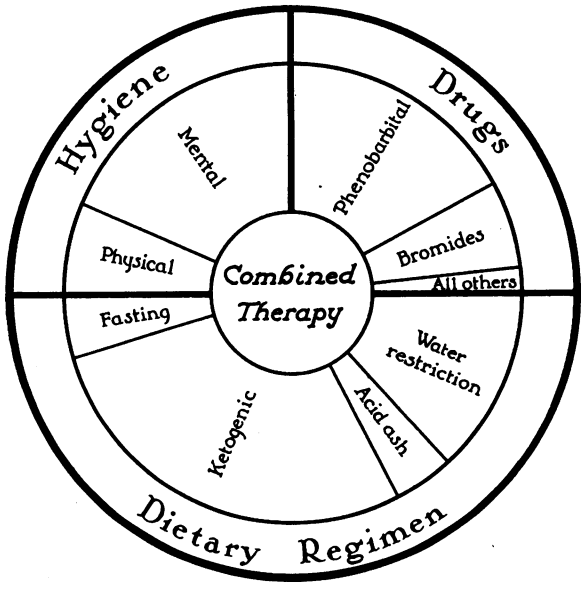

Fig. 5.—Graphic representation of the various aspects of antiepileptic therapy as applied to children. Relative importance of each factor indicated by size of sector.

be allowed can be laid down for application in all cases, because the requirements vary so widely for different conditions, such as age, muscular activity, and atmospheric conditions. After seizures have been brought under control, sufficient water must be given with the diet to meet all of the physiological requirements, including the process of growth, with unimpaired efficiency. Since sweet milk, which is especially desirable for younger children, cannot be given in adequate amounts, an incomplete substitute can be made by adding 3.5 grams of casein powder (casec) and 46 grams of water to 50 grams of heavy cream, and seasoning the mixture with saccharin and salt. The regimen must be sufficiently elastic to permit adequate adjustment to changing requirements.

Practical Management of the Dietary Regimen. Experience in the practical management of the dietary regimen has demonstrated that a combination of the foregoing dietetic principles yields more satisfactory results from all points of view than any single regimen alone. A preliminary fast of several days' duration is often desirable. Moderate restriction of the total water and salt intake in conjunction with the ketogenic diet permits a more liberal allowance of carbohydrate, while use of a mildly ketogenic or borderline diet in connection with the low-water exchange regimen makes the degree of water restriction required for control of seizures less extreme and so more tolerable to the patient. The addition of some acid-forming salt (as a substitute for table salt) and very dilute hydrochloric acid (as a substitute for vinegar in salad dressings and pickles) in amounts at least sufficient to neutralize the excess base in alkaline-ash foods, increases the effectiveness of either of the above regimens alone or of the two in combination. The combined regimen is most likely to be effective when the specific gravity of the urine ranges above 1028, and the urine color changes to a deep brown (positive test for diacetic acid) upon addition of an excess of 10 per cent ferric chlorid solution. The constituents of the diet should be carefully weighed, especially at the beginning of treatment, and until they can be fairly accurately estimated. The diet must be made varied and attractive.

To simplify calculation of the ketogenic, low-water diet according to the total caloric, protein and water requirements for children of different ages and weights, the general guide shown in Figure 8 can be employed. All that is required for its use are knowledge of the patient's age and weight, and a standard table of food values. The factor, by which the body weight is multiplied in the equation for estimating fat, is one derived more or less empirically from average figures for caloric requirements of children under conditions of moderate activity. Variations in its value for different ages or weights involve assumed differences in protein and carbohydrate as well as caloric requirements. Diets calculated according to this guide should provide a metabolic mixture having a ketogenic to antiketogenic ratio of approximately 3:1. The water allowance per unit of body weight is inversely proportional to the age, the larger allowance being intended for the younger and the smaller for the older children. Individual readjustments in the diet must be made from time to time according to the patient's response. Most of the foods suitable for this type of diet are given, for the sake of convenience, in Table 1. The values as listed are for uncooked foods. Baking causes a loss of from 20 to 30 per cent in the water content of meats and vegetables. A sample menu calculated from this table on the basis of the above guide is presented in Table 2.

Drug Therapy.—Drug therapy for epilepsy in children has tended to become less important since the introduction of the dietary regimen outlined above. Nevertheless, for the vast majority of patients being treated in general practice, special medication still holds a prominent place, if indeed it is not the only type of therapy available. Where possible, drugs should be used merely to supplement the forms of management already described. *Phenobarbital* or luminal is the most satisfactory single agent so far discovered for control of seizures over long periods of time. The dose for children varies between one-half grain (0.03 gram) once daily, and one and one-half grains (0.09 gram) twice daily. The time-honored *bromids,* which have been almost completely replaced by phenobarbital because of their disagreeable taste, their unpleasant effect on the appetite and their tendency to cause unsightly skin eruptions, still hold a place of usefulness in those cases which for any reason respond unsatisfactorily to this newer drug. Theoretically, the acid-forming salts, $CaBr_2$ and NH_4Br, should be superior to the sodium and potassium salts, because they possess an acidogenic as well as the sedative action. It is well known that a low NaCl intake enhances the

therapeutic effects of the bromid salt. Children require larger doses of bromids per unit of body weight than do adults, the dosage for the former ranging between 15 to 45 grains (1 to 3 grams) daily in divided doses. Other medicinal agents, such as atropin, calcium and magnesium salts, ephedrin, parathormone, iodids, borotartrates, diuretics, cathartics and opiates, may be helpful in rare cases under special conditions, but they hold only a small place in the therapeutic scale.

Management of the Patient During Convulsions.—This phase of our discussion would be incomplete without reference to the subject of management of the patient during convulsions. Practically all that can be done for the patient during a seizure is to protect him against bodily injury. This necessitates constant companionship, especially in severe cases which have no warning aura. If the patient is standing or sitting when a seizure begins, he should be placed on the floor or a bed with a soft support for his head. His clothing should be loosened about the neck, and a wedge of soft wood or firm rubber should be placed between his teeth to prevent biting of the tongue and lips. Repeated severe convulsions occurring at frequent intervals (*status epilepticus*) are undoubtedly harmful and even dangerous to life, a fact which necessitates the use of heroic therapeutic measures. Ether or chloroform inhalation by means of a face mask to a stage of light anesthesia is probably the safest and most successful method for immediate control of the seizures. Sodium amytal or chloral hydrate and ammonium bromid should then be administered per rectum, in doses appropriate for the age, every two hours for two or three doses. Thereafter, the patient can be given other medication by mouth. A single dose of from 2 to 8 grains of luminal sodium may be given intravenously or intramuscularly in 5 cubic centimeters of physiological saline solution as a substitute for the amytal or chloral. If facilities are available for the administration of respiratory gases, a mixture of 10 per cent carbon dioxid and 90 per cent oxygen may be more desirable than chloroform or ether in exceptional cases, but in our experience is less effective in the majority of instances. Drainage of fluid from the subarachnoid space by lumbar puncture, while the patient is under the anesthetic, is a common practice. As soon as medication can be given by mouth, several large doses of magnesium sulphate should be given for the dehydrating effect. The diuresis following the administration of urea in doses of 10 to 15 grams every six hours is probably just as effective in this regard, and is less distressing to the patient. An initial intravenous injection of hypertonic sucrose solution to cause withdrawal of water from the brain would be a rational procedure, since this sugar is later excreted quantitatively in the urine. Fasting and moderate restriction of the water intake for two to three days after recovery from an attack of *status epilepticus* prepares the patient for a new start on the regular therapeutic regimen.

SUMMARY

Idiopathic epilepsy, as the most obscure representative of a large group of so-called functional convulsive disorders, is discussed from the points of view of etiologic mechanism and therapy.

The etiologic problem is considered from two main aspects: (1) that relating to the underlying abnormality responsible for the characteristic proneness to convulsive seizures, and (2) that concerning the contributing factors.

The relative merits of each of the several types of available therapy are discussed. Simplified procedures for calculating the special diets advised are presented. The desirability of utilizing all of the tried therapeutic measures simultaneously is emphasized.

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